Latent Liquidity and Corporate Bond Yield Spreads

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Abstract

Recent research has shown that default risk accounts for only a part of the total yield spread on risky corporate bonds relative to their riskless benchmarks. One candidate for the unexplained portion of the spread is a premium for the illiquidity in the corporate bond market. We investigate this issue by relating the liquidity of corporate bonds, as measured by their ease of market access, to the non-default component of their respective corporate bond yields using the portfolio holdings database of the largest custodian in the market. The ease of access of a bond is measured using a recently developed measure called *latent liquidity* that weights the turnover of funds holding the bond by their fractional holdings of the bond. We use the credit default swap (CDS) prices of the bond issuer to control for the credit risk of a bond. At an aggregate level, we find a contemporaneous relationship between aggregate latent liquidity and the average non-default component in corporate bond yields. Additionally, for individual bonds, we find that bonds with higher latent liquidity have a lower non-default component of their yield spread. We also document that bonds that are held by funds that exhibit greater *buying* activity command lower spreads (i.e., are more expensive), while the opposite is true for those that exhibit greater *selling* activity. We also find that the liquidity in the CDS market has an impact on bond pricing, over and above bond-specific liquidity effects.

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1 Introduction

Corporate bonds are amongst the least understood instruments in the financial markets. This is surprising given the sheer size of the US corporate bond market, about 4.5 trillion dollars outstanding at the end of 2004, which makes such bonds an important source of capital for firms around the world. These bonds carry a risk of default, and hence command a yield premium or spread relative to their riskless counterparts. However, the academic literature in finance has been unable to explain a significant component of corporate bond yields/prices in relation to their treasury counterparts, despite using a range of pricing models and calibration techniques.

Prior studies have noted that although default risk is an important determinant of the spread, there are other factors such as liquidity, taxes, and aggregate market risk variables (other than credit risk) that may also play a significant role in determining the spread. Of these other factors, it has been conjectured that liquidity effects have the largest role to play in the pricing of corporate bonds.[1] Unfortunately, the non-default component of corporate bond yields/prices has been inadequately studied, largely due to the paucity of relevant data. In particular, the absence of frequent trades in corporate bonds makes it difficult to use market micro-structure measures of liquidity based on quoted/traded prices or yields to measure liquidity, as has been done in the equity markets. It is difficult, therefore, to measure the liquidity of corporate bonds directly. Consequently, it is fruitless to *directly* study the impact of liquidity on corporate bond yields and prices, thus leaving the discussion of the non-default component of corporate bond spreads somewhat incomplete.

In this paper, we provide a partial answer to this question using a new measure of liquidity, called latent liquidity, proposed by Mahanti et al. (2006), which is based on the pattern of holdings of bonds by investors, and thus does not require a large number of observed trades. This measure weights the turnover of the funds that own the bond by their fractional holdings; thus, it is a measure of the *accessibility* of a bond to market participants. The attractive feature of this measure is that it circumvents the problem of availability of transaction data for corporate bonds and yet provides a reasonable proxy for liquidity.

[1] See, for example, the discussion below on papers by Longstaff et al. (2005), Elton et al. (2001), Eom et al. (2003) and others.

We study the relationship of the latent liquidity measure with bond prices and yields. Specifically we focus on the component of bond yield spreads (over the corresponding riskless benchmark) that is *not* explained by default risk, and relate it to the ease of access of the bonds, as measured by latent liquidity. This approach allows us to analyze a broad sample of bonds, many of which trade infrequently, to examine liquidity effects in their pricing. We use the premium from the credit default swap (CDS) market for the issuer of the bond to control for the default risk component. The non-default component is computed using two alternate specifications for the benchmark - the treasury curve and the swap curve - as proxies for the risk-free term structure of interest rates.

We use a unique database of corporate bonds assembled by one of the largest custodians in the market in our measurement of latent liquidity. Our approach, using this metric of liquidity, has several unique advantages, as argued by Mahanti et al. (2006). First, it allows us to access information across a large number of dealers. Second, because the custodian has information regarding the ultimate ownership of the bonds, it is possible to compute a holdings-based measure of the accessibility of the bonds. Third, it allows us to separate the aggregate liquidity measure into "buy" and "sell" liquidity measures.

The analysis in this paper focuses on how the latent liquidity of corporate bonds affects their yields/prices, after taking into account the default risk component. We document several relationships in our study. We find that latent liquidity explains a statistically and economically significant part of bond yields. We first document the inverse relationship between the non-default component of the bond yield spreads and latent liquidity at the aggregate level over time. We next confirm, in the cross-section of bonds in our sample, the traditional hypothesis that the greater the liquidity, the lower the non-default component of their yield spreads, and hence, the greater their prices.[2] We find that latent liquidity as a measure of liquidity has an effect on bond prices *over and above* realized measures of liquidity such as trading volume. In addition, latent liquidity at the beginning of the month can be used to *predict* the non-default component of the yield spread during the month, as opposed to trading volume which is only available ex-post.

We also explore the sources of liquidity in greater detail and split up the measure between

[2]The earliest proponents of this hypothesis were Amihud and Mendelson (1986).

buy (fractional holdings weighted by buying turnover) and sell latent liquidity (fractional holdings weighted by selling turnover). Further analysis leads us to the conclusion that bonds that are easier to sell (as measured by high buy-latent liquidity) are more expensive while bonds that are easier to buy (as measured by high sell latent liquidity) tend to be less expensive. This can also be thought of in terms of buying pressure and selling pressure. Bonds that are held to a greater extent by funds with higher selling turnover are likely to be under selling pressure in the market, while bonds that are held to a greater extent by funds with a higher buying turnover are likely to be under buying pressure.

In addition to studying the liquidity effects in the corporate bond market, we also examine liquidity effects in the CDS market. This is intuitive because the non-default component is really the expected return on a strategy that holds a long position in the bond, along with protection bought in the CDS market, and is thus affected by both bond market and CDS market liquidity. Hence, the non-default component of the bond yield spread reflects a premium for the *relative* illiquidity of the corporate bond market compared with the CDS market. For measuring the liquidity in the CDS market, we use more traditional liquidity metrics such as bid-ask spreads and trading activity, to the extent that they are available in our sample. Given the higher liquidity in the CDS market, in many cases, such metrics of liquidity may be meaningful. We find that, over and above bond-specific liquidity measures, the liquidity of the corresponding CDS contract affects bond prices. Bonds of issuers whose CDS contracts enjoy greater liquidity tend to be more expensive (have lower yields) in the cross-section, compared with their less liquid counterparts, after adjusting for various bond characteristics. We also examine several relationships documented in the previous literature about the effect of factors like coupon, amount outstanding, age and trading volume on the liquidity of bonds on the non-default component of the yield spread, using a much more current and extensive data-set than has been used in previous studies.

This paper is divided into the following sections. Section 2 offers a review of the existing literature on the yield spreads of corporate bonds. Section 3 describes our data sources. Section 4 discusses the latent liquidity measure proposed by Mahanti et al. (2006) and the manner in which we measure the non-default component of corporate bond spreads. Section 5 discusses the results of our study. Section 6 concludes.

2 Literature Review

Our paper is related to three different strands in the academic literature. First, there is a vast literature on the impact of illiquidity on asset prices. Although most of this literature is related to equity prices, the broad issues analyzed are applicable to corporate bonds. Second, there is a burgeoning literature that seeks to explain the yield spreads of corporate bonds over their treasury benchmarks. While the major component of the spread is attributed to the default component of these bonds, there is a large unexplained portion that has been variously attributed to tax, liquidity, market risk and other effects. The third strand of the literature attempts to measure liquidity in the context of a highly illiquid market such as the market for corporate bonds.

There is a considerable volume of literature, particularly in the past two decades, that attempts to describe the effect of liquidity on asset prices. Most of this literature has to do with the concept of liquidity costs and associated liquidity premia in stocks, although there is a somewhat sparse, recent, literature that deals with corporate bonds. While a comprehensive survey of this literature is beyond the scope of this study, we touch upon a few contributions that underpin the prevailing academic perspective on the effects of liquidity on asset prices.[3] In an early contribution in this area, Amihud and Mendelson (1986) argue that transaction costs result in liquidity premia in equilibrium, reflecting the differing expected returns for investors with different holding times who have to defray their transaction costs. There is an implicit clientele effect, due to which securities that are more illiquid, and are cheaper as a result, are held in equilibrium by investors with longer holding periods. This work has been extended and modified in different directions over the years.[4]

A closely related branch of literature has to do with modeling these liquidity costs. The sources of liquidity costs are two-fold: the inventory carrying costs of the dealer and the information asymmetry costs faced by the dealer in relation to informed trades.[5] On the empirical side, the

[3] The literature on liquidity effects in the broad context of asset pricing is too vast for us to detail here. See Amihud et al. (2006) for a comprehensive survey.

[4] See Huang (2003) and Acharya and Pedersen (2005), for examples.

[5] There is a vast literature, particularly dealing with the latter explanation, with Kyle (1985) being a prominent example. Again, see Amihud et al. (2006), for more details.

literature has primarily dealt either with the equity market or the market for government bonds, both of which are characterized by high trading volumes and a large number of participants. There are a few notable exceptions of researchers who have studied corporate bonds. The earliest study of this nature is by Fisher (1959), who uses the amount outstanding of a bond as a measure of liquidity and the earnings volatility as a measure of the credit risk of the firm, and finds that yield spreads on bonds with low issue sizes (illiquid bonds) are higher. Also notable is a recent paper by Chen et al. (2007), who provide a method of estimating transaction costs in the corporate bond market and relating them to corporate bond returns. Our paper uses more detailed data on holdings of bonds to construct an alternative measure of liquidity, which can be used even in the absence of transaction cost information.

In a parallel development, there have also been attempts to decompose the yield spread on corporate bonds in terms of the components that are related to the defaultable nature of these securities, and to other components. For instance, Eom et al. (2003) and Huang and Huang (2003) use structural models to explain the spreads on corporate bonds and find that most structural models are able to explain only a part of corporate bond spreads if reasonable parameters are assumed for the firm value process. Elton et al. (2001) find evidence of a significant tax effect in corporate bonds that is attributable to the differential treatment of coupons on corporate bonds relative to treasury securities. An important related paper in this strand of the literature is by Longstaff et al. (2005), who fit a common model of credit risk both to corporate bonds and to credit default swaps. They find evidence of a significant non-default component in the spread and are able to relate it to the coupon as well as variables that are related to the liquidity of a bond, such as the amount outstanding (in the cross-section), bid/ask spreads, and the liquidity premium for on-the-run treasury securities in the time series. Blanco et al. (2005) take another approach to the problem by studying the co-integration relationship between corporate bond spreads and CDS spreads. They document the presence of a strongly mean reverting non-default component in corporate bond yields. They also find, based on their model of information flows, that the CDS market leads the corporate bond market, and that most of the corrections introduced by this lead-lag relationship take place through the non-default component of corporate bond yields.

The other strand of the literature that is pertinent to our research here is the work on measures of liquidity that are appropriate for the corporate bond market. Some papers that study liquidity effects using transactions based data on bonds include Chakravarty and Sarkar (1999), Hong and Warga (2000), Schultz (2001) and Hotchkiss et al. (2002). More recently, there is a paper by Houweling et al. (2005) that uses liquidity-sorted portfolios in the European market, constructed using nine proxies for liquidity including issued amount, listed, euro, on-the-run, age, missing prices, yield volatility, number of contributors, and yield dispersion. Using a multi-factor model to control for interest rate and credit risk, they find evidence of a significant liquidity premium. In a similar vein, De Jong and Driessen (2006) and Downing et al. (2006) use multi-factor models that include liquidity in the equity market as well as the treasury market, and find evidence of significant liquidity premia in corporate bonds. All these papers attempt to study illiquidity by examining transactions data. Unfortunately, this approach may not always be feasible in the extremely illiquid corporate bond market. Our method uses holdings data which provide measures of liquidity even when transactions in individual bonds are not very frequent. Potentially, our approach could yield deeper insights into the role of illiquidity in determining corporate bond yields.

The concept of latent liquidity that is used in this paper draws from Mahanti et al. (2006). That paper introduces the measure and relates it to bond-specific characteristics, such as maturity, age, coupon, rating, the presence or absence of put/call options and other covenants. In section 4, we discuss the concept of latent liquidity, and the extensions of the basic concept to buy versus sell latent liquidity that we use later on, in our analysis of corporate bond prices.

3 Data Sources

Our primary source of data is the corporate bond holdings and transactions database of State Street Corporation (SSC), the largest custodian in the global financial market. A custodian provides trade clearance, asset tracking, and valuation service support to institutional investors. The client of the custodian is the fund, i.e., the owner of the asset, who may deal with diverse broker-dealers. All these trades are cleared through the custodian, who thus has access to information about a larger number of trades than an individual broker-dealer. In addition, custodians have access to information on who *holds* the corporate bonds, and this allows the construction of the latent liquidity measure that we employ in this research.

Our database contains traded prices for corporate bonds for the period from 1994 to 2005. In addition, the end-of-month holdings information on all the bonds in our sample is also available, based on which the latent liquidity measure is computed. The database covers around 15% of all bonds traded in the US markets and is reasonably representative of the overall US corporate bond market, as we show below.[6] A brief description of the construction of the latent liquidity measure is presented in section 4.

The prices for the CDSs are obtained from a database supplied by GFI, the leading broker in the CDS market.[7] The database covers over 2000 leading corporate names on which credit protection is bought or sold on a fairly regular basis. It includes daily prices for CDSs for the period from April 1999 to July 2005. There are several advantages to using this data-set:

- It covers a longer time period than has been covered by previous studies. Most notable amongst these studies is Longstaff et al. (2005), which uses a proprietary database of CDS prices that covers 52 firms over a much shorter time period (from March 2001 to October 2002). The data-set used by Blanco et al. (2005) covers only 33 firms from Jan 2001 to June 2002.

- There have been significant changes in the market for corporate bonds with the advent of hedge funds and credit derivatives over the last ten years. The data-set covers the latter half of this period, and thus, includes more recent data. This is in contrast to the data used by many of the previous studies on corporate bond yields, which are, in many cases, based on the Warga Fixed Income Securities Database (1997).[8]

- The data-set contains quotes by a large number of CDS market-makers, and is thus quite inclusive and reliable.

[6] For a detailed exposition and analysis of the representativeness of the database, please refer to Mahanti et al. (2006).

[7] More information about GFI and their CDS database is available at http://www.gfinet.com.

[8] See for example papers by Elton et al. (2001), Huang and Huang (2003), Eom et al. (2003) and others.

The prices in the database could be either transaction prices or mid-quotes. We aggregate this data in different ways to obtain measures of the prices and liquidity in the CDS market. The quotes include both bid and ask quotes, in addition to transacted prices of each CDS contract. We take the average of the quotes every day; in some cases, there are several quotes available each day. We also compute the number of trades and available quotes on any given day (whether bid or ask) for each name. In order to integrate the data sources, the names in the CDS database are matched with the corporate bond issuers in the database of corporate bonds.

Table 1 shows the top forty names (by number of quote dates) on which CDS contracts are traded. One can see that there is considerable variation in the number of daily quotes for the CDS contracts, both in the cross-section and in the time-series, as indicated by the average number of quotes, and the minimum and the maximum number of quotes. The variation in the mid-point of the CDS quotes is also considerable, thus indicating that the database spans a large variation in the prices of credit risk for each of the issuers. On most names, there are only a few actual CDS trades on a daily basis, with some names trading as infrequently as once every few months. Most of the liquidity in the CDS is concentrated in the five-year maturity bucket, which is the bucket used by most market participants for calibration purposes. For this reason, we use the five-year maturity bucket in our analysis.

Data on interest rates, such as treasury yields and swap rates are obtained from Datastream. These data are also matched with those on corporate bond and CDS trades in our data-set, assembled from SSC and the GFI. In order to focus on the pricing of corporate bonds, we restrict our attention to data on days on which we observe a quote in *both* the CDS market and a trade in the corporate bond market. This eliminates, as far as possible, timing mismatches in the data, and accurately captures the effect of time variation in the default risk inherent in the bond.

To actually estimate the non-default component of the yield spread, we employ a set of filters to ensure that we have sufficient data, and that the data are properly matched between the corporate bonds and the credit derivatives. We eliminate all issuer names that have less than 300 days of quotes available in the CDS database over our sample period. In addition to this filter, we choose bonds that have a final maturity between 4 years and 6 years on the date on which they are traded.

This allows for a reasonably good match between the maturity of the CDS contract and the bond maturity, since both of them measure firm credit risk over similar horizons. Finally, we match the trade date of the bonds with that of the CDS contract and construct a panel consisting of a cross-section of corporate bonds and their price observations on the days on which trades occurred, along with CDS prices for the dates on which the corporate bonds traded. It is this panel that is used for the computation of the non-default component of the corporate bond spread. For each observation, we have the corresponding bond characteristics, such as coupon, rating, outstanding volume, and the latent liquidity of the bond.[9]

Table 2 shows selected statistics on the top forty names (by number of bonds) in the combined sample. It is evident from the table that here is considerable variation in the CDS premium and the yield spreads in these bonds. However, it can be seen that for most cases, the CDS premium is only a fraction of the corporate bond yield spread, indicating that only a part of the yield spreads on bonds can be accounted for by credit risk.

Table 3 shows the decomposition of the sample into industry groups, along with a summary of the SSC database of holdings of State Street Corporation, and the universe of bonds tracked by the Lehman Brothers Credit Indices. We find that the single largest industry group represented in the sample is Financial Services, followed by Media and Telecommunications. Industrials and Utilities make up a relatively small proportion of the sample. All three data-sets are roughly similar in that they are heavily biased towards Financial Services, and have similar proportions of Telecommunications, Technology and Manufacturing firms, indicating that the sample is quite representative of the overall market, as captured by the Lehman universe.

Similarly, Table 4 shows the decomposition of the sample by their initial Moody's credit ratings. The sample is skewed towards investment-grade bonds, because these are the ones that are traded more relatively frequently *and* also have CDS contracts traded at the same time. In spite of these apparent biases, however, this sample is reasonably representative of the overall composition of the investment grade corporate bond market, though not of the corporate bond market as a whole. Table 4 also shows the rating distribution in the holdings database as well as the overall universe.

[9] In the empirical estimations, we assign a numerical score to the credit rating according to the following scheme: Aaa - 1, Aa -2 , A - 3, Baa - 4.

The top four ratings account for around 74% of all corporate bonds outstanding. This leads us to the conclusion that the exclusion of the remaining categories from our data-set is not a very severe problem. The sample is broadly similar to the samples used in prior studies of the corporate CDS market, but with many more observations, both cross-sectionally and over time.[10]

There are 698 bonds in our sample, and 167 issuers, with a total of around 15,000 trade observations, which is a much larger set than previous studies using CDS data. However, since the latent liquidity measure is available at a monthly frequency, for any given bond, we take the average of the non-default component for that month, and match it with the latent liquidity at the beginning of month. This still leaves us with around 3579 matched observations. Elton et al. (2001) use around 700 bonds, but they do not use CDS data. Furthermore, as discussed earlier, many of the studies using only corporate bond data use data from before 1996.

Table 5 shows the summary statistics for the sample of bonds that we obtain after the filtering process, averaged at the level of the bond. It can be seen that there is considerable variation in both the latent liquidity and the trading volume of the bond (the two main liquidity variables that we use in the bond market), as well as the non-default component in bonds.

4 Methodology

4.1 Latent Liquidity

In this section, we describe in brief the methodology used to compute the latent liquidity measures, including the buy and the sell latent liquidity measures. In simple terms, latent liquidity is the weighted average turnover of the funds holding a particular bond, the weights being the fractions of the total outstanding amount of a bond held by various funds at the beginning of the month.[11] The argument behind this computation is that since there is considerable persistence in turnover, bonds that are held by funds that have a larger turnover are likely to be more accessible and hence more highly traded. Mahanti et al. (2006) show that this measure of latent liquidity is correlated

[10] See, for example, Longstaff et al. (2005).

[11] For a more detailed description of the computation, as well as the relationship between latent liquidity and bond characteristics, the reader is referred to Mahanti et al. (2006).

with other transaction-based measures of liquidity, such as trading volume and bid-ask spreads, in the relatively liquid segment of the market where reliable micro-structure based data are available . However, the advantage of this measure is that it does not require trade-based information, and is thus available ex-ante, for a broader cross-section of bonds.

Let $\pi^i_{j,t}$ denote the fractional holding of a bond i by fund j at time t. Let $T_{j,t}$ denote the average portfolio turnover of a fund in the months from t to $t-12$, where turnover is defined as the ratio of the dollar trading volume of the fund between time t and$t-12$ to the value of the fund at time t. The latent liquidity measure for bond i at time t is simply defined as:

$$L^i_t = \sum_j \pi^i_{j,t} T_{j,t} \tag{1}$$

Equation 1 yields a monthly value for the latent liquidity of each bond in our sample. Note that, in this sense, the latent liquidity of the bond indicates the ease with which a dealer can locate the bond in order to fulfill a buy order. It does *not* necessarily indicate the ease with which the bond may be sold, although an argument can be made that funds with a higher turnover are more likely to add to their existing holdings of corporate bonds than funds with a lower turnover.

There is, however, a way of splitting up the latent liquidity measure into buy and sell latent liquidity, based on the nature of the funds holding the bonds. This can be done by measuring the turnover of "buys" and the turnover of "sells" separately for individual funds, and then weighting them by the fractional holdings. The implicit assumption is that the past selling turnover is a good predictor of future selling turnover, and that the past buying turnover is a goof predictor of future buying turnover.Let $\pi^i_{j,t}$ denote the fractional holding of a bond i by fund j at time t. Let $T^B_{j,t}$ denote the average buying portfolio turnover of a fund in the months from t to $t-12$, where buying turnover is defined as the ratio of the dollar buying volume of the fund between time t to $t-12$ to the value of the fund at time t. The buy-latent liquidity measure is simply:

$$L^i_{Bt} = \sum_j \pi^i_{j,t} T^B_{j,t} \tag{2}$$

The sell- measure is defined similarly as

$$L^i_{St} = \sum_j \pi^i_{j,t} T^S_{j,t} \tag{3}$$

These two measures, respectively called buy- and sell-latent liquidity are measures of buying and selling activities of the funds holding the particular bond. We will use these measures subsequently in our analysis.

4.2 The Non-default Component of Corporate Bonds

The recent academic literature on corporate bond pricing has attempted to isolate the component of corporate bonds that is *not* caused by default risk (the non-default component). Most of the earlier papers in this area use an explicit model for pricing credit risk.[12] However, the advent of the CDS market makes it possible to isolate default risk in corporate bonds issued by a certain issuer without relying too heavily on a particular model of credit risk and a specific parameterization, since one more reading of the market price of credit risk becomes available. Most credit default swap contracts specify a particular reference asset, but allow for settlement by physical delivery of other similar obligations of the same issuer.[13] Hence, since CDS contracts price default risk explicitly, they are a good benchmark for the pure credit risk of the firm, and hence apply to all its obligations. Indeed, as argued by Duffie (1999), to a first-order approximation, there is an equivalence between the CDS price and the spread on the floating rate obligation of a similar maturity issued by a firm. It must be noted that most corporate bonds issued by firms tend to be fixed-rate bonds, and thus this equivalence does not hold exactly. More importantly, as shown

[12] For example, see papers by Huang and Huang (2003) and Eom et al. (2003).

[13] There are some recent moves to switch to cash settlement, rather than physical delivery, to avoid the possibility of a squeeze on the reference bond.

by Longstaff et al. (2005), the corporate bond spread is biased, depending on the probability of default.

This equivalence is further complicated by differing definitions in the CDS contract, especially in the early years of our sample period. However, with the increasing use of standard International Swaps and Derivatives Association (ISDA) agreements between counter-parties, this is less of a problem in recent years. Even so, the problem of delivery terms remains. In case of a default, a typical CDS contract requires the delivery of the reference obligation (or a similar obligation) in exchange for face value. However, if the deliverable bonds are illiquid, the seller of the CDS (protection) who needs to deliver them may incur an additional liquidity cost to source the bonds in the market.

Subject to the above caveats, there are essentially two different approaches to isolate the non-default part of the corporate bond spread, which could then be related, in part, to liquidity effects. One possible approach is to use the difference between the corporate bond spread and the CDS spread as a model-independent (albeit noisy) proxy for the non-default component of the corporate bond yield spread. An alternative approach, proposed by Longstaff et al. (2005), is to apply a theoretical model of credit risk to price both the CDS and the corporate bonds simultaneously. This latter method has the advantage that any potential biases are addressed explicitly. However, the procedure is dependent on the choice of the credit risk model, and the literature on credit risk models shows us that there remain significant pricing errors in all the models that have been used so far.[14] In this paper, we follow the method used by Longstaff et al. (2005) to estimate the non-default component of the corporate bond yields. Details of our methodology are provided in the Appendix.

Following Grinblatt (2001) and Longstaff et al. (2005), we use two alternate benchmarks for the risk-free rate - the par yield curve on US treasuries and the USD-LIBOR swap curve, both of which are available from Datastream.[15] We linearly interpolate between points on the two curves to obtain the corresponding par curves at semi-annual intervals. These par curves are then bootstrapped to

[14]See Huang and Huang (2003) and Eom et al. (2003) for tests of a range of credit risk pricing models.

[15]As discussed below, neither curve provides a pure risk-free benchmark that is uncontaminated by liquidity effects. The former has clear liquidity effects embedded into the pricing of the on-the-run bond, while the latter has a small credit risk premium, due to the difference between the treasury and LIBOR rates, built into it.

get discount factors at each semi-annual interval. We then fit a cubic spline to the discount factors to get a functional form for the discount function $D(t)$, for both specifications of the benchmark curve.

We make the assumption that the prices of credit default swaps reflect the true price of credit risk (or, even if they do not, the errors are unbiased and not related to liquidity). Under this assumption, we evaluate the risk-neutral default intensity, λ, by assuming values for the parameters α, β, σ and δ, using equation A-4 above. This value of λ is then used to fit the prices of all bonds by the same issuer. In short, we use the price of the credit default swaps to fit the value of λ, as on any given date. We then we use the λ so computed in the price for the bond on that date and obtain a value for the non-default components γ, using equation A-4. Given the maturity filter that we apply on the bonds, every bond remains in our sample for a maximum of two years. The time-series average of non-default components during these two years is used in the subsequent cross-sectional study. We obtain two sets of cross-sectional estimates for the non-default component of the bond yield spread, using swap rates and treasury rates as the benchmark risk-free rates, respectively. It turns out that the value of the non-default component is not very sensitive to the choice of model parameters in both cases.

An important issue to address here is the issue of "shorting" costs. When the non-default component of the yield spread in a bond is positive, a hypothetical arbitrage strategy would involve holding the bond and buying protection on it through the CDS contract to maturity. This has the effect of hedging away the credit risk in the bond, while earning the non-default component. On the other hand, if the non-default component is negative, the arbitrage strategy involves shorting the bond and selling protection on it through the CDS contract. Shorting corporate bonds is costly because corporate bonds are difficult to "find" in the securities borrowing and lending market.[16] Typically, a rebate rate is paid on the cash collateral that is used to borrow a bond, and if this rebate rate is less than the repurchase rate on general collateral in the market, it constitutes a cost to an agent that shorts a bond. The shorting cost is priced into the bond, and constitutes a "negative" non-default premium, when such an arbitrage strategy is profitable. This could explain

[16] See Duffie (1996) and Duffie et al. (2002) for details of the implications of shorting costs.

the fact that the non-default component is often negative when CDS spreads are extremely high.

We have access to a data-set for realized borrowing costs, but unfortunately this data-set covers only a small part of our sample period. In this limited sample, we find that shorting corporate bonds is almost always costly, with an average shorting cost of 0.48% (calculated as the difference between the general collateral (GC) rate and the rebate rate on a bond). Shorting costs are typically high when firms are in financial distress, and hence have high CDS spreads. These costs can be quite high. There are several instances of bonds having a zero rebate rate when borrowed, indicating that the shorting cost was as high as the general collateral rate itself.

Since we do not have data on shorting costs for our entire sample, it is difficult to analyze the impact of shorting costs on the non-default component. For the limited data that we have, we find little relationship between shorting costs and latent liquidity. If this relationship extends to the larger sample, we do not expect shorting costs to bias the results of our study.

4.3 Liquidity in the CDS market

The non-default component of the yield spread may reflect the *relative*illiquidity of the corporate bond versus the corresponding CDS. Therefore, in addition to bond-specific liquidity, we study measures of CDS liquidity that have an effect on the corporate bond prices. The intuition behind this, as stated earlier, is that the non-default component in the bond price represents an investors' expected return in a strategy that involves holding a long position in the bond and buying protection on the issuer in the CDS market. Such an investor will demand compensation for the relative illiquidity in the CDS market compared with the corporate bond market.

We consider two different measures of the liquidity of the CDS contract. The first is the bid-ask spread as a percentage of the CDS price. The percentage bid-ask spread indicates the ease with which a buyer may buy or sell a CDS contract. A higher spread indicates difficulty of trading, since it indicates higher transaction costs, as in Amihud and Mendelson (1986). The other measure of CDS market liquidity that we consider is the average number of quotes on a contract, as available to our inter-dealer broker, per day. A larger number of quotes indicates greater liquidity in the CDS contract.

5 Results

5.1 Bond Characteristics, Latent Liquidity and Other Liquidity Metrics

In order to study the relationship between latent liquidity and other bond-specific variables, we first perform simple OLS regressions on bond-wise averages of latent liquidity on other variables, similarly aggregated bond-wise. Table 6 shows the determinants of average latent liquidity for the bonds in our sample. It shows that the age of the bond is the most significant determinant of latent liquidity. Both measures of credit quality - the initial credit rating of the bond and the average CDS spread on the issuer - imply that in our sample, bonds of poorer credit quality have higher latent liquidity. Bonds that trade less frequently and bonds with lower outstanding volumes tend to have lower latent liquidity. The coupon yield of the bond does not seem to have any explanatory power once we control for age. This relationship is slightly different from that reported in Mahanti et al. (2006) for a much larger cross-sectional sample, over a somewhat longer period, for which they find that the higher coupon bonds tend to have greater latent liquidity. This difference could be the result of the nature of our more recent sample period, which is mostly during a period of declining interest rates. In this period, the older bonds tend to have higher coupons, and this explains the fact that controlling for age removes all explanatory power from the coupon rate of the bond. Also, the Mahanti et al. (2006) use a much larger sample of bonds, some of which barely trade. Their sample includes many bonds that have a much lower latent liquidity than those included in this study.

We also add two liquidity variables from the CDS market: the percentage bid/ask spread on the CDS contract, and the average number of daily quotes on the name, in order to investigate if there are any cross sectional differences in bond liquidity that are driven by CDS market liquidity. We find that the percentage bid-ask spread on the CDS contract has some explanatory power for the latent liquidity of the bond. This is over and above the bond-specific liquidity variables that we mention above. In all, using these factors, we are able to explain about 28% of the variation in average latent liquidity in the cross-section of bonds in our sample.

5.2 Aggregate Latent Liquidity and Time-Series Relationships

We first examine the effect that aggregate latent liquidity of the bonds in our sample has on their average non-default component. The aggregate latent liquidity is the simple average of the latent liquidity of bonds included in our sample in any given month.[17] This aggregate analysis is important because any bond stays in our sample for at most two years, and not all bonds in our sample have price observations for every month. Hence, it is difficult to study the time-series relationship between the non-default component for an individual bond and the liquidity related variables. However, this analysis can be conducted at an aggregate level by treating our sample as a portfolio and computing the average non-default component using all bonds for every month, and similar monthly averages of the other measures. An additional advantage of this approach is that errors in measurement of latent liquidity for individual bonds are unlikely to be correlated across bonds. Hence portfolio-level average latent liquidity is significantly less noisy than the latent liquidity of individual bonds.[18]

Figure 1 shows the variation of the non-default components using swap rates and treasury rates over time, along with the average latent liquidity of the bonds in the sample. The negative correlation between the latent liquidity and non-default component becomes apparent. The relationship is particularly pronounced in the period prior to July 2002. July 2002 marks the introduction of compulsory trade-reporting on the Trade Reporting and Compliance Engine (TRACE) system, subsequent to which the average non-default component has declined. There is some recent literature on the improvement in market transparency as a result of the introduction of real-time

[17]This measure has an intuitive interpretation in terms of the average turnover of funds. Summing equation 1 over i gives us:

$$\begin{aligned} L_t &= \frac{\sum_i \sum_j \pi^i_{j,t} T_{j,t}}{i} \\ &= \frac{\sum_j \sum_i \pi^i_{j,t} T_{j,t}}{i} \\ &= \frac{\sum_j T_{j,t}}{i} \end{aligned} \tag{4}$$

This is equal to the average turnover of funds under the assumption that the ratio of the number of funds to the number of bonds stays constant over time. It is a measure of aggregate corporate bond market liquidity. However, this does not necessarily hold for a sub-sample of bonds.

[18]We discuss the nature of measurement error in latent liquidity in section 5.3.

TRACE reporting. Edwards et al. (2007) document that bid-ask spreads in TRACE eligible securities have declined by around 5 basis points due to increased transparency. Similar evidence is provided by Goldstein et al. (2005) and Bessembinder et al. (2005). The decline in the average non-default component is suggestive of a reduced liquidity premium after the introduction of the TRACE reporting system, and is thus consistent with the micro-structure literature on transaction costs in corporate bonds. However, as is shown subsequently, a large part of this reduction in the average non-default component can also be attributed to increased liquidity of the CDS market. The subsequent analysis confirms this hypothesis.

Table 7 shows the effects in a regression of the average non-default component in a given month, on the aggregate latent liquidity in that month and on other variables, including the average coupon, the average bid-ask spread in the CDS market, and the average number of daily quotes in the CDS contracts in that month. To control for autocorrelation in the disturbances, we introduce an AR(1) term in the regression. We also include the average coupon of the bonds traded, since as bonds move in and out of our sample, the average coupon changes and we suspect that this might have implications for the non-default component, if coupon effects are important. The results indicate that an increase in the average latent liquidity is accompanied by a decrease in the average non-default component, relative to both the treasury rate and swap curve benchmarks. A unit change in the latent liquidity or four sample gives rise to a 38 basis point reduction in the average non-default component relative to treasury rates and a 26 basis point reduction in the non-default component relative to swap rates. A one standard deviation increase in the average latent liquidity of the sample gives rise to an 11 basis point reduction in the average non-default component (relative to treasury rates) and an 8 basis point reduction in the non-default component (relative to the swap curve). In comparison, the standard deviations of the non-default components (relative to the treasury and swap curve benchmarks) are 21 basis points and 8 basis points respectively. This indicates that the results are both statistically and economically significant.

In addition, the liquidity of the CDS market has explanatory power for the non-default component relative to treasuries, as well. An increase in average CDS bid-ask spreads drives the average non-default component up, while an increase in activity as measured by the number of quotes, drives it down. Of the two measures of CDS market liquidity, the bid-ask spread seems to have greater explanatory power in explaining the non-default component of the yield spread on the bonds of the respective issuer.

5.3 Cross Sectional Determinants of the Non-Default Component of the Yield Spread

Section 5.2 suggests that there is a strong time-series relationship between the average non-default component and latent liquidity. By construction, a bond stays in our sample only when it is traded and for a maximum period of two years. Since latent liquidity is measured with a monthly frequency, it is difficult to perform a time-series study for every bond, especially given some missing observations for each bond, due to lack of trading. However, we can examine the cross sectional relationship across bonds for every month for which latent liquidity is measured. In order to do this, we compute the average monthly non-default component for every bond and match it with the latent liquidity at the beginning of the month, along with other bond-specific variables for that month. This gives us about 3759 bond-month combinations. We next perform cross-sectional bond-wise regressions for every month for which we have a minimum of 30 bonds. We have 60 such months in our sample. We then average these coefficients across time, and compute their standard errors. The advantage of using this approach is that we are able to focus on only the cross-sectional differences between different bonds. Any variation that arises either because of systematic effects or because of the use of treasury rates versus swap rates as the benchmark does not affect our results. This procedure is similar to the one described by Fama and Macbeth (1973) for the computation of stock βs. Hence, as in their case, the issue of measurement error in the independent variable -latent liquidity in our case - becomes important for several reasons:

- The funds in the database that we use are only a fraction, albeit a significant and representative one, of the total universe of agents holding corporate bonds. Hence, a latent liquidity measure computed using our database is likely to be a noisy, but unbiased, estimate of the "true" liquidity of the bond, especially when the bond is young and is rapidly changing in ownership.

- We use the turnover of funds in the twelve months preceding the period over which the variable is measured, rather than the (unknown) contemporaneous or future turnover.

- The variable is a stock, rather than a flow, measure and is only available as of the beginning of every month.

These errors are not likely to affect regressions on aggregate latent liquidity, because we have no reasons to believe that the errors in latent liquidity measurement across bonds are correlated. However, caution should be exercised while using latent liquidity in a linear regression system at the level of each bond, because the measurement error in latent liquidity can attenuate the regression coefficients. In what follows, we briefly discuss the nature of errors in measurement of latent liquidity.

Figure 2 shows the evolution of the latent liquidity of the average bond in the sample as it ages. The figure shows that latent liquidity of a bond declines rather rapidly in the first few months since it is issued. This happens because bonds quickly change hands from funds that trade very actively to funds that trade relatively less actively. Since we are able to measure the latent liquidity only with a monthly frequency, the latent liquidity measure cannot account for the rapid changes in liquidity, particularly when bonds are young. As a result of this, there are likely to be significant measurement error in latent liquidity when the bonds are young. Therefore, due to our inability to observe the fluctuations in latent liquidity within the month, we do not include the observations on bonds that are less than six months old.

5.4 Latent Liquidity and the Non-Default Component of the Yield Spread

Tables 8 and 9 show the relationship between the non-default component of individual corporate bonds, bond-specific characteristics and liquidity for a range of alternate specifications that include latent liquidity and other bond-specific and CDS-specific liquidity measures. For both swap rates (Table 9) and treasury rates (Table 8), Model 1 shows that in a univariate regression of the non-default component on overall latent liquidity, latent liquidity has significant explanatory power. The coefficient of the latent liquidity variable is negative, indicating that an increase in latent liquidity of the bond leads to a decrease in the non-default component of the yield, and consequently, an increase in the bond price.

The inclusion of the coupon rate shows that the coupon rate has significant explanatory power, both for the specification with treasury yields and for the one with swap rates. Traditionally, as in Elton et al. (2001), this relationship has been explained away as a tax effect. However, as has been argued more recently by Longstaff et al. (2005), the tax treatment on coupon income and swap rates is the same, and therefore, one would not expect to find a tax effect in explaining the difference between corporate bond yields and the swap rates. The fact that part of the tax effect remains even when swap rates are used indicates that this explanation can only be partly true, at best. Hence, the similar values of the coefficient of the coupon rate in the case of both swap and treasury rates casts doubt on the conventional explanation of the coupon effect as being due to differential taxation of corporate versus treasury bonds.

On closer examination, there are other reasons to be skeptical about the tax effect in corporate bond yields. First, there is anecdotal evidence that many of the participants in the corporate bond markets, such as long term pension funds, are tax-exempt. Even hedge-funds, which in recent years have become significant players in the CDS and CDO markets as well as the corporate bond market directly, tend to be tax-neutral. Given the large sizes of these two segments of the market, it is difficult to believe that the marginal investor in the corporate bond market has a strong tax preference. Second, as documented in Longstaff et al. (2005), this effect persists even when the Refcorp or swap term structures, which also have the same tax treatment as corporate bonds, are used as default-free interest rate benchmarks. This is, in fact, an independent robustness test. Third, the significant coefficient of the coupon rate variable persists even after the inclusion of a large number of liquidity related variables.

The coupon effect could point to the inadequacy of reduced-form models to price coupon-bearing bonds. One explanation proposed by Geske (1977) is that the holder of a coupon-bearing bonds is short a compound-put option, and hence higher coupon bonds might have a lower price. Another possible explanation is that in the relatively low interest rate environment that characterizes the time-period of our sample, higher coupon bonds tend to have a substantial premium. In such an environment, hedging the default risk in a corporate bond with a CDS, a common strategy among market participants, has substantial implementation problems. If default occurs on a bond that was bought at a premium to par, the protection on the bond is only up to the face value of that bond in a typical CDS contract. Hence, an investor holding a premium bond that defaults unexpectedly loses more relative to an investor holding a par bond by the same issuer. This could result in aversion on the part of investors to hold higher coupon bonds, and this aversion could result in a greater required yield on the bonds. The required return on higher coupon bonds would be higher in a lower interest rate environment, because the bond would have a greater premium. This issue remains to be investigated further, when a much larger data set becomes available.

The coefficient of the latent liquidity variable remains highly significant, even after we add other (measureable) variables that have been associated with liquidity in corporate bond liquidity. These include the amount outstanding of the bond and its age. The negative sign on the age variable is surprising because it indicates that conditional to the bond being traded, older bonds are actually more expensive indicating that the market views them as being more liquid.

In addition to these variables, we include the average number of trades in the bond, and two variables related to CDS market liquidity. The significance of the latent liquidity variable stays intact even after all these variables are added, indicating that latent liquidity has information over and above that contained by other measures of bond-market liquidity. Overall, using swap rates and treasury rates as alternative benchmarks, we find that latent liquidity has a statistically significant cross sectional impact on the level of the non-default coefficient. Economically speaking, this means that latent liquidity in itself creates a difference of about 5 basis points per unit change in latent liquidity in the cross-section *after* all other effects have been accounted for. Given the range of latent liquidity in our sample, this implies a 20 basis point difference between the most liquid and the least liquid of bonds in our sample. This is quite significant in economic terms.

The relationship between the non-default component and the number of trades in the bond is also significant. Note that the number of trades is a measure of the realized liquidity of the bond. As expected, it has a significant negative coefficient. It also reduces the explanatory power of latent liquidity. This is again predictable, because, as documented in Mahanti et al. (2006), latent liquidity drives trading activity. However, it should be noted that for every time period, latent liquidity is available ex-ante, while the realized trading volume is an ex-post measure of liquidity. Thus, latent liquidity can be used to predict the non-default component in the bonds, as opposed to trading volume, which is only available ex-post.

In addition to bond specific liquidity, we find that bid-ask spreads and the number of quotes in the CDS market have explanatory power over and above the liquidity of the bond in itself. This is noteworthy, because it indicates that liquidity in the CDS market affects the prices of bonds in the cross section. This is a phenomenon that has not been documented in the previous literature. We find that both CDS market liquidity variables have a strong effect on the non-default component in the bond. However, of the two, the percentage bid-ask spread seems to have a higher explanatory power. As a robustness check, we test if this effect is driven by firm-level fixed effects. We do not report these results, because we find that the fixed effects are not significant. This is an interesting result because it shows that the CDS market liquidity has explanatory power on bond prices over and above bond-specific liquidity variables, and it is evidence, in the cross-section, of a liquidity spill-over from the CDS market into the bond-market.

For the specification using swap rates, the economic significance of latent liquidity is slightly higher. It remains to be investigated why there is a difference between the relationship when swap rates are used against when treasury rates are used. It is possible that the difference between swap rates and treasury rates is itself affected by aggregate liquidity in the fixed-income markets. Aggregate liquidity itself would affect the aggregate turnover of the funds. This would mean that bonds that are sampled during periods of high liquidity (a higher difference between swap rates and treasury rates) would also have a high latent liquidity number. This would result in a negative correlation between latent liquidity and the difference between the non-default component computed using treasury rates versus swap rates, thus explaining the higher coefficient when swap rates are used. We, however, remain agnostic about which benchmark to use. As shown in Feldhutter and Lando (2005), the "true" risk-less rate lies somewhere between treasury yields and swap rates. However, the fact that our result holds for both benchmarks that span the "true" risk-less rate gives us confidence that our results are robust to such a specification.

5.5 Buy-Liquidity and Sell-Liquidity and the Non-Default Component of the Yield Spread

Latent liquidity measures the ease of access of a bond, as measured by the turnover of funds that predominantly hold the bond. However, aggregate turnover, which would include both purchases and sales, might not be the most appropriate measure of buying or selling pressure, which may move the prices/yields in opposite directions. If a bond is held predominantly by funds that have a high buying turnover, it would make the bond easier to sell, because these funds are less likely to offload the bond in the market. Conversely, if the bond is primarily held by funds that have a high selling turnover, it would make it harder to sell, because the likelihood of these funds offloading the bond in the market is higher. We can thus compute two different measures of latent liquidity based on the buying and the selling turnover of funds. As explained in the methodology section, we call these two measures buy-latent liquidity and sell-latent liquidity, respectively.

We would expect the buying turnover and selling turnovers to be positively correlated because high volume funds will typically engage both in buying and selling. Indeed, this can be confirmed by the fact that the correlation between buy and sell latent liquidity in our sample is very high. However, there are significant buy-sell imbalances in the market for corporate bonds when they are young, and this leads to differences in buy-liquidity and sell-liquidity. Figure 3 shows the evolution of buy and sell measures of latent liquidity over time for the average bond in our sample. A large difference between buy and sell liquidity indicates that a bond is held to a greater extent by funds that are either buying more than they are selling or vice-versa. As can be seen, this difference is prominent initially after the bond is issued, and decreases thereafter. Since buying and selling imbalances in the turnovers of funds are likely to affect price pressure, we would expect the buy and selling liquidity measures to have opposing effects. Specifically, on young bonds, we expect the sign on the buy-latent liquidity measure to be negative (since it indicates ease of selling) and the sign on the sell-latent liquidity measure to be positive (since it indicates difficulty of selling).

Table 10 reports the results of a cross-sectional procedure similar to the one performed in section 5.4, with the buy- and sell-latent liquidity considered separately. We perform the regressions for bonds that are less than two years old, and again exclude months that have less than thirty cross-sectional observations. We find that the results are significant and consistent with our expectations. The buy-latent liquidity and the sell-latent liquidity measures take opposite and statistically significant signs. Thus, there is information contained in buy- and sell-liquidity, over and above all other realized measures of liquidity, despite the fact that these measures are highly correlated. The sizes of these coefficients are also quite large and economically significant.

6 Conclusion

The existing literature on the yield spread of US corporate bonds shows that the non-default component of corporate yields is related to factors associated with liquidity, such as age, outstanding amount and maturity. However, since liquidity metrics based on transaction prices and volumes are difficult to compute due to infrequent trading in the corporate bond market, this is virtually impossible to confirm at the level of individual bonds. We use a uniquely constructed data-set from the largest corporate bond custodian in the market to evaluate the ease of access of a bond using a recently developed measure called latent liquidity. We also use transactions data for the CDS market obtained from a leading broker, GFI, to adjust for the credit risk of the bonds, so that we can focus on the non-default component of these bonds.

First, we confirm several relationships documented in the previous literature on about the effect of factors like coupon, amount outstanding, age and trading volume on latent liquidity in the corporate bond market, on a much more current and extensive data-set, and in particular, on the latent liquidity measure. Second, we show that the average level of the non-default component in our sample is contemporaneously related to its average latent liquidity. An increase in average latent liquidity leads to a decrease in the average non-default component. Third, at the level of individual bonds, we link latent liquidity to the yields/prices of the bonds, and find that bonds that are primarily held by funds that trade actively are more expensive, when adjusted for credit risk, than those that are held by funds that trade less actively. Additionally, the effect of latent liquidity on the non-default component is not fully captured by the realized trading volume, in spite of the fact that the latent liquidity measure is available ex-ante, as opposed to trading volume which is available ex-post. Further, on closer examination, we find that in the period just after issuance, bonds held by funds that have a higher buying turnover are more expensive than bonds primarily held by funds that have a higher selling turnover. This shows that, in addition to the fact that aggregate accessibility of bonds is priced, the accessibility for buyers and sellers is priced differently.

Finally, we have a unique result that shows that the liquidity of the CDS contract, as evidenced both by bid-ask spreads and trading activity, has an explanatory power for the non-default component of bonds that is over and above bond-specific liquidity variables. This is true both in the cross-section, at the level of individual bonds, and at an aggregate level, in the time series. This is convincing evidence that bond market participants account for the liquidity of the CDS market when they price corporate bonds. Accordingly, as the CDS market becomes more and more liquid, we expect the non-default component in the bonds to decrease over time.

In conclusion, we present and validate a measure of corporate bond liquidity that is available ex-ante, does not require transaction data, has additional explanatory power, and offers interesting insights into processes that drive liquidity in the corporate bond markets. In addition, we demonstrate that liquidity in the CDS market affects the prices of the underlying corporate bonds.

Appendix

We assume that the CDS prices reflect the true probability of default and infer the non-default component of the bond prices by jointly fitting a credit risk model to both the CDS and the corporate bond prices. The method uses an affine model of credit risk and a random walk process for the non-default component. The model for the probability of default is an affine jump diffusion model of the form:

$$d\lambda = (a - b\lambda)dt + \sigma\sqrt{\lambda}dz_{\lambda} \tag{A-1}$$

where λ is the risk-neutral jump intensity. The non-default component γ is given by:

$$d\gamma = \eta dz_{\gamma} \tag{A-2}$$

Appealing to the affine nature of the specification permits the derivation of simple closed-form solutions to both the corporate bond price and the CDS premium that are exponentially affine in λ_t and γ_t, the risk-neutral probability of default and the non-default component of the spread, respectively. Following Longstaff et al. (2005), the price of a corporate bond of maturity T, coupon c and loss-given-default w is given by:[19]

$$\begin{aligned} CB(c,w,T) = c\int_0^T & A(t)exp(B(t)\lambda)C(t)D(t)e^{-\gamma t}dt \\ & + A(T)exp(B(T)\lambda)C(T)D(T)e^{-\gamma T} \\ & + (1-w)\int_0^T exp(B(t)\lambda)C(t)D(t)(G(t)+H(t)\lambda)e^{-\gamma t}dt \end{aligned} \tag{A-3}$$

[19] For a more detailed description refer to Longstaff et al. (2005).

The price of a CDS is given by:

$$s = \frac{w \int_0^T exp(B(t)\lambda)D(t)(G(t) + H(t)\lambda)dt}{\int_0^T A(t)exp(B(t)\lambda)D(t)dt} \tag{A-4}$$

where

$$A(t) = exp\left(\frac{\alpha(\beta+\phi)t}{\sigma^2}\right)\left(\frac{1-\kappa}{1-ke^{\phi t}}\right)^{2\alpha/\sigma^2}$$

$$B(t) = \frac{\beta-\phi}{\sigma^2} + \frac{2\phi}{\sigma^2(1-\kappa e^{\phi t})}$$

$$C(t) = exp\left(\frac{\eta^2 t^3}{6}\right)$$

$$G(t) = \frac{\alpha}{\phi}(e^{\phi t}-1)exp\left(\frac{\alpha(\beta+\phi)}{\sigma^2}t\right)\left(\frac{1-\kappa}{1-\kappa e^{\phi t}}\right)^{2\alpha/\sigma^2+1}$$

$$H(t) = exp\left(\frac{\alpha(\beta+\phi)+\phi\sigma^2}{\sigma^2}t\right)\left(\frac{1-\kappa}{1-\kappa e^{\phi t}}\right)^{2\alpha/\sigma^2+2}$$

where

$$\phi = \sqrt{2\sigma^2+\beta^2}$$

and

$$\kappa = (\beta+\phi)/(\beta-\phi)$$

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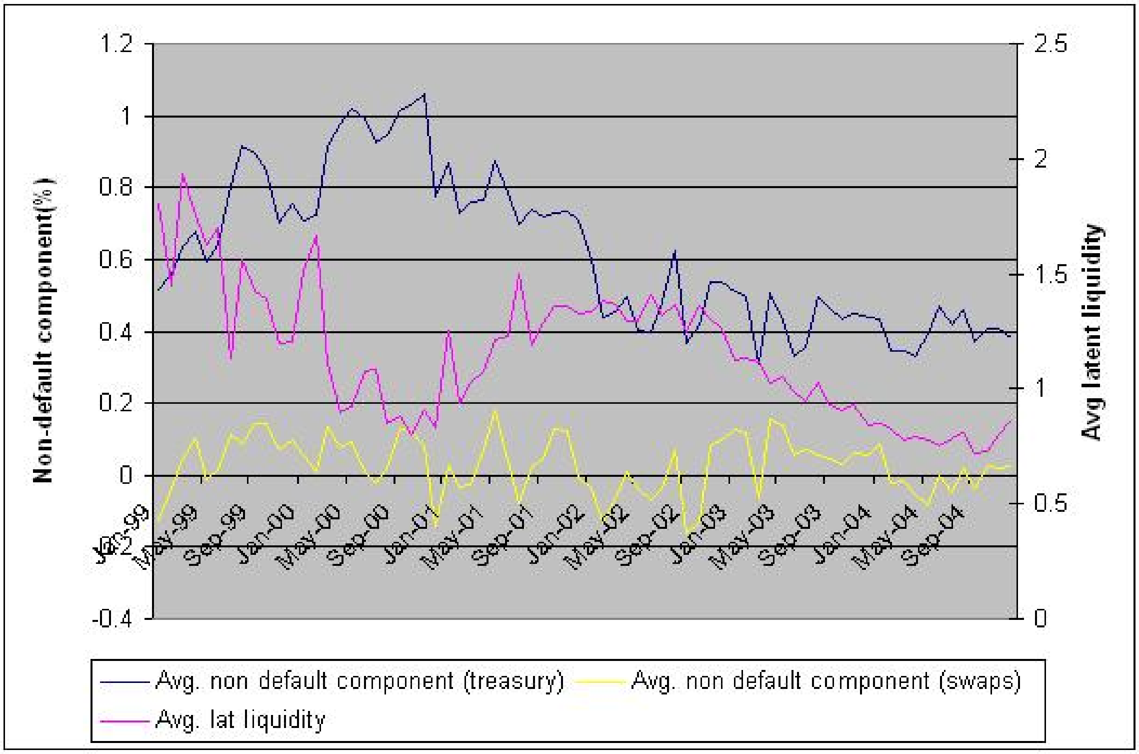

Figure 1: **Average latent liquidity and the non-default component of the yield spread over time:** This plot shows the average latent liquidity of the sample of bonds and the associated non-default component of their yields relative to treasury rates and swap rates over the period from January 1999 to January 2005, using a sample of 3,579 matched observations. Latent liquidity is a liquidity measure that weights the turnover of funds holding the bond by their fractional holdings of the bond. July 2002 marks the introduction of the TRACE reporting system. The non-default component of the yield spread is measured relative to swap rates and treasury yields of the corresponding 5 year maturity.

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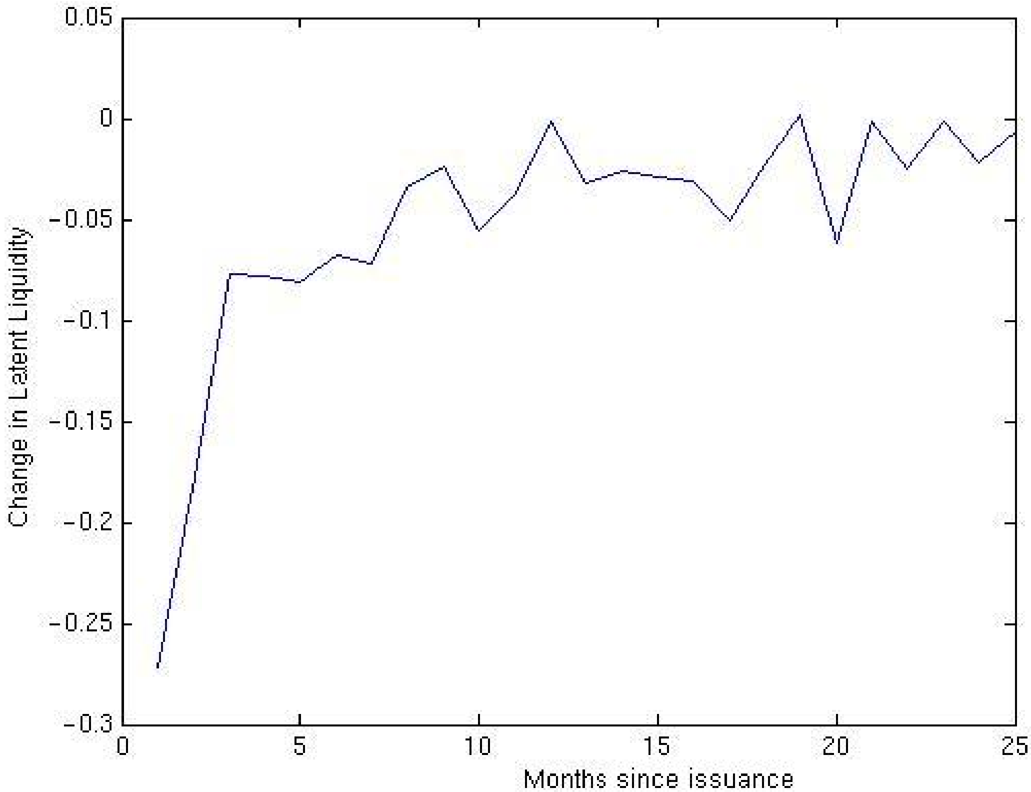

Figure 2: **Rate of change of latent liquidity in relation to time since issuance:** This plot shows the rate of change of latent liquidity in the months after a bond is issued for the average bond in our sample of 3,579 matched observations from January 1999 to January 2005 in relation to the time since issuance of the bond. Latent liquidity is a liquidity measure that weights the turnover of funds holding the bond by their fractional holdings of the bond.

Figure 3: **Buy- and sell-latent liquidity in relation to the age of a bond:** This plot shows how the buy- and sell-latent liquidity measures change over time in our sample of 3,579 matched observations from January 1999 to January 2005 in relation to the age of the bond. Latent liquidity is a liquidity measure that weights the turnover of funds holding the bond by their fractional holdings of the bond. The buy- and sell-latent liquidity measures take into account buying and selling turnover, respectively.

			Quotes			CDS price (bps)		
Issuer Name	Industry	Days quoted	Average	Min	Max	Average	Min	Max
FORD MOTOR CREDIT COMPANY	Financial	1373	12.21	1	82	199	20	672
GENERAL MOTORS ACCEPTANCE CORPORATION	Financial	1314	11.35	1	63	168	24	441
JPMORGAN CHASE AND CO	Financial	1164	4.15	1	16	45	16	129
AT&T CORP	Communications	1069	10.24	1	90	177	17	700
BANK OF AMERICA CORPORATION	Financial	1056	3.46	1	14	39	15	135
SEARS ROEBUCK ACCEPTANCE CORP	Consumer, Cyclical	1004	6.66	1	56	118	22	458
DELPHI CORPORATION	Consumer, Cyclical	925	7.44	1	102	151	62	367
GOLDMAN SACHS GROUP, INC.	Financial	911	3.54	1	17	45	21	113
LEHMAN BROTHERS HOLDINGS INC.	Financial	892	3.89	1	13	57	24	118
MERRILL LYNCH & CO., INC	Financial	889	4.17	1	16	50	21	136
HSBC FINANCE CORP	Financial	872	5.15	1	42	118	20	878
BEAR STEARNS COMPANIES INC.	Financial	854	3.67	1	18	53	24	125
MOTOROLA, INC.	Communications	846	5.71	1	32	188	19	563
MORGAN STANLEY	Financial	813	4.41	1	18	46	20	97
SPRINT CAPITAL CORPORATION	Communications	763	7.42	1	29	195	37	1268
HEWLETT-PACKARD COMPANY	Technology	747	3.92	1	15	89	17	293
VISTEON CORPORATION	Consumer, Cyclical	742	8.19	1	37	263	74	442
GENERAL ELECTRIC CAPITAL CORP	Financial	690	5.70	1	27	46	14	121
CIT GROUP INC	Financial	689	6.12	1	34	123	30	823
TIME WARNER INC.	Communications	685	7.28	1	29	159	35	875
CITIGROUP INC.	Financial	677	3.88	1	11	35	13	96
EASTMAN KODAK COMPANY	Industrial	671	6.33	1	48	140	18	396
INTERNATIONAL PAPER COMPANY	Basic Materials	671	3.47	1	15	82	35	150
WALT DISNEY CO	Communications	671	6.00	1	32	74	17	195
COUNTRYWIDE HOME LOANS, INC.	Financial	647	5.15	1	20	67	35	178
VIACOM INC.	Communications	640	4.56	1	23	62	22	156
FEDERATED DEPARTMENT STORES, INC.	Consumer, Cyclical	635	5.41	1	23	78	26	178
COX COMMUNICATIONS INC	Communications	616	5.36	1	52	128	35	550
RAYTHEON CO	Industrial	615	3.83	1	22	100	26	203
GOODYEAR TIRE & RUBBER COMPANY	Consumer, Cyclical	614	5.13	1	34	428	30	1375
DOW CHEMICAL COMPANY	Basic Materials	608	6.11	1	37	94	28	246
TOYS 'R' US, INC.	Consumer, Cyclical	601	6.69	1	52	263	55	700
COMPUTER ASSOCIATES INTERNATIONAL INC	Technology	572	5.41	1	38	197	43	950
ALBERTSON'S INC	Consumer, Non-cyclical	570	5.19	1	22	76	36	185
IBM	Technology	568	3.95	1	15	43	13	116
CAPITAL ONE BANK	Financial	560	5.43	1	30	161	39	933
BOEING CO	Industrial	548	4.37	1	20	53	17	140
AT&T WIRELESS SERVICES INC	Communications	543	6.34	1	45	184	21	1025

Table 1: **Summary statistics of the top forty (by number of trades) issuer names in the CDS database:** This table presents the summary statistics of the top forty names in our database covering over 2000 CDS names from August 1999 to July 2005. The columns show the name of the issuer, its Bloomberg industry classification, the number of days on which the CDS contract was traded, the number of quotes available per day, and the CDS spread in terms of average, maximum and minimum. There is considerable cross-sectional as well as time-series variation in the number of quotes for each CDS contract, as is seen in the average, maximum and minimum columns for the number of quotes. The data set also covers a wide variation in the CDS prices, as can be seen by the maximum and minimum mid-quotes for each of the issuers.

Issuer	Industry	Number of Bonds*	Spread Average	Average CDS	Average Basis/Spread	Non-default component over swaps Average	Max	Min	Days Traded**	Issue Size (USD mio) Minimum	Maximum
Citigroup Inc.	Financial	33	1.062	0.347	0.674	0.072	0.888	-0.367	644	100	2000
General Electric Capital Corp	Financial	27	0.925	0.496	0.464	-0.161	0.548	-0.575	589	65	2000
Hsbc Finance Corp	Financial	26	2.066	1.566	0.242	-0.059	0.641	-4.983	897	60	2000
Merrill Lynch & Co., Inc.	Financial	25	0.996	0.430	0.569	-0.026	0.820	-0.660	486	100	2000
Verizon Global Funding Corporation	Communications	21	1.414	0.883	0.375	-0.073	2.124	-2.778	221	125	2000
Wachovia Corporation	Financial	21	0.933	0.286	0.694	0.042	0.564	-0.736	207	100	1750
Ford Motor Credit Company	Financial	20	2.413	1.883	0.220	-0.036	0.974	-1.242	1687	300	2000
General Motors Acceptance Corporation	Financial	19	2.293	1.780	0.224	-0.102	0.701	-0.849	1063	25	2000
Lehman Brothers Holdings Inc.	Financial	19	1.351	0.563	0.583	0.110	0.663	-0.702	542	100	1750
Bear Stearns Companies Inc.	Financial	16	1.178	0.468	0.602	0.037	0.529	-0.210	263	150	1000
Wells Fargo & Company	Financial	14	0.838	0.288	0.657	-0.079	0.516	-0.303	154	150	1500
International Lease Finance Corporation	Financial	13	1.347	0.745	0.447	0.019	0.505	-1.664	218	100	900
Countrywide Home Loans, Inc.	Financial	12	1.278	0.703	0.450	-0.029	7.094	-0.531	339	111	1625
IBM	Technology	10	0.927	0.489	0.473	-0.185	0.287	-0.439	94	100	1500
Morgan Stanley	Financial	10	1.194	0.483	0.595	0.044	0.681	-0.446	536	100	2000
Dominion Resources, Inc.	Utilities	10	1.347	0.739	0.451	-0.026	0.314	-0.739	79	150	700
Cit Group Inc	Financial	9	2.004	1.429	0.287	-0.053	0.606	-1.018	307	200	1250
Cox Communications Inc	Communications	9	1.779	1.126	0.367	-0.104	0.427	-1.341	120	100	800
Kroger Co.	Consumer, Non-cyclical	9	1.593	0.855	0.464	0.116	0.396	-0.239	138	200	750
Raytheon Co	Industrial	9	1.790	1.146	0.360	-0.057	0.456	-0.773	228	225	1000
Comcast Cable Communications, Inc.	Communications	9	1.516	1.007	0.336	-0.046	2.021	-0.914	279	150	800
Target Corporation	Consumer, Cyclical	8	0.953	0.383	0.598	-0.039	0.298	-0.309	98	200	750
Capital One Bank	Financial	7	1.956	1.091	0.442	0.074	0.748	-0.356	220	200	1250
Clear Channel Communications Inc	Communications	7	1.949	1.409	0.277	-0.156	0.279	-1.309	157	125	750
Progress Energy Inc	Utilities	6	1.723	1.096	0.364	-0.047	0.383	-1.189	42	200	800
Sears Roebuck Acceptance Corp	Consumer, Cyclical	6	2.708	1.993	0.264	0.082	0.709	-0.549	53	15	750
Sprint Capital Corporation	Communications	6	3.355	2.371	0.293	-0.161	1.089	-3.130	460	750	1721
Union Pacific Corporation	Industrial	6	1.175	0.512	0.565	0.067	0.342	-0.380	50	150	350
Washington Mutual, Inc.	Financial	6	1.108	0.497	0.551	0.001	0.500	-0.478	118	150	1000
Goldman Sachs Group, Inc.	Financial	6	1.021	0.395	0.614	0.073	4.088	-0.188	259	113	2000
Boeing Capital Corporation	Financial	5	1.517	0.762	0.498	-0.019	0.263	-0.352	67	200	1000
Dow Chemical Company	Basic Materials	5	1.506	0.914	0.394	0.069	0.405	-0.407	82	200	500
Duke Energy Corporation	Utilities	5	1.138	0.574	0.495	-0.002	0.306	-0.448	64	200	500
International Paper Company	Basic Materials	5	1.325	0.657	0.504	0.026	0.263	-0.152	18	150	600
Kraft Foods Inc.	Consumer, Non-cyclical	5	1.100	0.589	0.465	-0.095	0.340	-0.647	71	400	1250
Lockheed Martin Corporation	Industrial	5	1.356	0.605	0.554	-0.015	0.144	-0.189	79	391	993
Norfolk Southern Corp	Industrial	5	1.382	0.582	0.579	0.119	0.508	-0.202	57	200	750
Praxair Inc	Basic Materials	5	1.090	0.338	0.690	0.130	0.405	-0.135	21	250	300
Time Warner Inc.	Communications	5	2.923	2.363	0.192	-0.167	0.619	-1.482	244	166	1000
Viacom Inc.	Communications	5	1.393	0.678	0.513	0.001	0.386	-0.367	160	397	1650

*Only Bonds with maturity between 4-6 years as of trade date

**Days on which both CDS and a bond between 4-6 year maturity traded

Table 2: **Summary statistics of the top forty (by number of bonds in sample) issuers in the combined data-set:** This table shows the summary statistics of the top forty (by number of bonds) issuers in the combined CDS-bond data-set of 3,579 matched observations from January 1999 to January 2005. We match the CDS for each reference entity to trades in a senior unsecured corporate bond issued by that reference entity with a maturity between 4 years and 5 years in order to generate the combined data set. The columns show the number of bonds in our sample, the average yield spread over a comparable treasury bond, the average CDS price, the ratio of the average basis (defined as the difference between the spread on the bond and the CDS price) to the spread over treasury, the non-default component relative to the swap curve, the number of days for which we have observations, and the issue sizes of the bonds. There is considerable variation in the credit spread on the bonds and the amount issued per bond. Twenty two of these issuers appear in the top 40 CDS names by volume.

Sector	Lehman Credit Universe	State Street Holdings	Sample
	As % Of Total	**As % Of Total**	**As % Of Total**
Basic Materials	3.7%	4.1%	7.5%
Communications	14.9%	12.9%	17.5%
Consumer, Cyclical	6.7%	7.3%	5.0%
Consumer, Non-cyclical	10.2%	9.8%	5.0%
Diversified	0.2%	0.1%	0.0%
Energy	5.7%	6.9%	0.0%
Financial	44.5%	42.3%	45.0%
Industrial	6.6%	7.1%	10.0%
Technology	1.4%	1.6%	2.5%
Utilities	6.2%	8.0%	7.5%
Grand Total	**100.0%**	**100.0%**	**100.0%**

Table 3: **Distribution of bonds by industry sector:** This table presents the composition, by industry category, as defined by Bloomberg, of our sample in relation to the Lehman aggregate credit universe as of December 2004. The first column defines the industry categories, and the second column shows the percentage of outstanding amount represented by that industry category in corporate bonds. The second column shows a similar decomposition for State Street holdings, from which our sample is drawn, and the third shows the decomposition for our sample which has been matched with CDS quotes.

Credit Rating	Lehman Credit Universe	State Street Holdings	Sample
	As % Of Total	**As % Of Total**	**As % Of Total**
Aaa	5.72%	7.55%	4.01%
Aa	16.19%	19.92%	13.90%
A	23.88%	22.83%	45.85%
Baa	23.88%	23.51%	36.25%
Ba	7.25%	7.37%	-
B	9.58%	10.94%	-
Caa	3.86%	3.70%	-
C	3.10%	1.29%	-
Other or NA Grade	6.55%	2.88%	
Total	**100%**	**100%**	**100%**

Table 4: **Distribution of bonds by Moody's initial credit rating:** This table presents the composition, by credit rating, as defined by Moodys, of US corporate bonds outstanding, as estimated by Bloomberg, as of December 2004. The first column defines the nine credit rating categories, and the second and third columns show the decomposition for the overall universe and for State Street holdings respectively. The fourth column shows the decomposition for our sample. The last column indicates the relative amount in the custody of State Street Corporation, as a fraction of total US dollar amounts outstanding, in each credit rating category.

Variable	Mean	Std. Dev.	Min.	Max.	N
Spread over Treasury	1.502	0.834	0.55	7.87	698
CDS spread (bps)	85.55	81.833	15	719.48	698
Coupon	6.288	1.379	2.7	11.62	698
Number of Days	17.585	33.708	1	354	698
Amount Outstanding (USD mio)	558.03	417.79	15.00	2000.00	698
Rating	3.143	0.801	1	4	698
Age	3.072	3.031	0.019	15.616	698
Latent Liquidity	0.998	0.464	0.030	4.65	698
Percentage Bid-Ask	0.175	0.116	0.0215	0.9	698
Average Daily Quotes	3.683	2.325	1	17.5	698
Non-default component (swaps)	0.047	0.367	-3	4	698
Non-default component (treasury)	0.543	0.390	-2	5	698

Table 5: **Summary statistics of the set of bonds in the sample:** This table shows the summary statistics of the combined data set that we obtain by matching the CDS prices obtained from GFI with corporate bond prices from the State Street Corporation database and computing the average non-default component for each bond in the sample. The summary statistics here are the yield spread over treasury rates, the CDS spread in basis points, the coupon rate, the number of days the bond is traded in the sample, the amount outstanding in million USD, credit rating, average age, latent liquidity, percentage bid-ask spread in the CDS contract, the number of daily quotes, and the non-default components computed using both the treasury yield curve and swap rates as the risk-free benchmark.

	Model 1	Model 2	Model 3
	(1)	(2)	(3)
Coupon	-.0004	-.0003	-.005
	(.006)	(.007)	(.007)
Initial Rating	.046***	.034***	.035***
	(.009)	(.010)	(.010)
Age	-.034***	-.035***	-.033***
	(.003)	(.003)	(.003)
CDS spread		.00009	.0001
		(.00008)	(.00008)
Amount Outstanding	6.07e-11***	2.50e-11	1.78e-11
	(1.42e-11)	(1.90e-11)	(1.94e-11)
Percentage Bid/Ask Spread			.435***
			(.106)
Average Daily Quotes			.001
			(.003)
No. of Days Traded		.0006**	.0008***
		(.0002)	(.0003)
Const.	.445***	.481***	.428***
	(.040)	(.043)	(.047)
Obs.	676	676	676
R^2	.256	.267	.287
F statistic	57.613	40.684	33.623

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Table 6: **Latent Liquidity and bond-specific variables in the sample of traded bonds**: This is a regression of latent liquidity on various bond specific factors, such as coupon and rating, liquidity factors like the amount outstanding, age and the number of days traded, and CDS market liquidity factors such as the percentage bid-ask spread in the CDS contract, and the average number of daily quotes. The sample uses 676 bonds obtained by matching corporate bonds from the State Street Corporation database with CDS prices on the names issuing those bonds, obtained from GFI, from January 1999 to January 2005. We match the CDS for each reference entity to trades in a senior unsecured corporate bond issued by that reference entity with a maturity between 4 years and 5 years in order to generate the combined data set. For the purpose of this regression, we use average values for each bond; that is, each variable is obtained by averaging its value over all the trades that we observe for a given bond-CDS pair. The maturity filter we employ implies that any given bond is in our sample for a period of two years at the most. Figures in brackets are standard errors.

	Treasury Rates	Swap Rates
	(1)	(2)
Latent Liquidity	-.389***	-.240**
	(.138)	(.110)
Coupon	.140***	-.010
	(.031)	(.026)
CDS Bid-Ask spread	.581*	.241
	(.299)	(.206)
Daily Quotes	-.058***	-.015
	(.013)	(.010)
AR(1)	-0.07	-0.24
	(.12)	(.15)
Obs.	73	73

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Table 7: **Effect of aggregate monthly latent liquidity on the average monthly non-default component under two different risk-free rate specifications**: These regressions show the effect of aggregate latent liquidity of the bonds in our sample, coupon, and the two CDS market liquidity variables on the non-default component in bonds. The sample includes observations on around 3579 bond-month observations obtained by matching prices and monthly latent liquidities from the State Street Corporation database with CDS prices obtained from GFI, over the period from August 1999 to July 2005. Not every bond is traded every month because bonds stay in the sample for a maximum of two years. The non-default component is computed using both treasury rates and swap rates. Dependent and independent variables here are averages across bonds for any given month. An auto-regressive term is added to control for serial dependence in the residuals. The regression is estimated using maximum likelihood and the standard errors noted are computed from the outer product of the gradients of the information matrix. Figures in brackets are standard errors.

	(1)	(2)	(3)	(4)
Latent Liquidity	-0.0626***	-0.0394***	-.0362***	-.0261*
	(.0.0114)	(.011)	(.0.012)	(.0.0139)
Coupon		.0534***	.055***	.064***
		(.005)	(.0064)	(.0077)
Age			-.004*	-.0049*
			(.0021)	(.0025)
Amount Outstanding (USD billion)			-.0455***	-.0455
			(.0106)	(.0021)
Number of Trades				-.0133***
				(.0045)
CDS Percentage Bid/Ask Spread				.2684***
				(.0964)
CDS Average Daily Quotes				-0.0068
				(.0093)
Const.	.5586***	.1987***	.193***	.1753***
	(.0239)	(.0414)	(.099)	(.0602)
Number of observations	2813	2813	2813	2813
Number of months	60	60	60	60
R^2	0.03	0.1136	0.1309	0.2026

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Table 8: **Cross sectional regressions of the non-default component using treasury rates**: These regressions show the effect of latent liquidity, coupon, amount outstanding, age, number of trades and the two CDS market liquidity variables, on the non-default component in the bonds. The treasury curve is used as the risk-less benchmark. The sample consists of around 2813 bond-month observations obtained by matching prices and monthly latent liquidities from the State Street Corporation database with CDS prices obtained from GFI, over the period from August 1999 to July 2005. We only include months for which we have observations on a minimum of thirty bonds. The regression gives average coefficients for the cross-section of bonds in our sample. Figures in brackets are Fama-Macbeth style standard errors. The total number of observations and the number of months over which the coefficients are averaged is also reported. Because the initial latent liquidity has large errors, these regressions only include bonds at least six months after they have been issued.

	(1)	(2)	(3)	(4)
Latent Liquidity	-0.0665***	-0.0416***	-.0375***	-.0275**
	(.0.0113)	(.0109)	(.0.0116)	(.0.0134)
Coupon		.0571***	.0573***	.0671***
		(.0055)	(.0066)	(.0076)
Age			-.0037*	-.0047*
			(.0022)	(.0026)
Amount Outstanding (USD billion)			-.0465***	-.0176
			(.0112)	(.0145)
Number of Trades				-.014***
				(.0045)
CDS Percentage Bid/Ask Spread				.2654***
				(.091)
CDS Average Daily Quotes				-0.0072
				(.0080)
Const.	.0837***	-.2998***	-.2581***	-.3171***
	(.0134)	(.0378)	(.0428)	(.0602)
Number of observations	2813	2813	2813	2813
Number of months	60	60	60	60
R^2	0.06	0.0774	0.0835	0.1060

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Table 9: **Cross sectional regressions of the non-default component using swap rates**: These regressions show the effect of latent liquidity, coupon, amount outstanding, age, number of trades and the two CDS market liquidity variables, on the non-default component in the bonds. The swap curve is used as the risk-less benchmark. The sample consists of 2813 bond-month observations obtained by matching prices and monthly latent liquidities from the State Street Corporation database with CDS prices obtained from GFI, over the period from August 1999 to July 2005. We only include months for which we have observations on a minimum of thirty bonds. The regression gives average coefficients for the cross-section of bonds in our sample. Figures in brackets are Fama-Macbeth style standard errors. The total number of observations and the number of months over which the coefficients are averaged is also reported. Because the initial latent liquidity has large errors, these regressions only include bonds at least six months after they are issued.

	Swap rates	Treasury rates
	(1)	(2)
Coupon	0.0907***	0.0871***
	(0.015)	(0.016)
Buy-liquidity	-0.0971*	-0.0836*
	(0.0521)	(0.0535)
Sell-liquidity	0.1793***	0.1589***
	(.0450)	(0.0461)
Number of Trades	-0.00855***	-0.00863***
	(0.00153)	(0.00154)
Percentage CDS Bid/Ask Spread	.0088	.00735
	(0.093)	(0.094)
Number of CDS Daily Quotes	-0.0163***	-.0164***
	(0.00381)	(0.00386)
Const.	-.501	.0251
	(0.061)	(0.059)
Observations	1977	1977
Months.	47	47
R^2	0.092	.172

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Table 10: **Effect of buy- and sell-latent liquidity on the non-default component under two different risk free rate specifications**: These cross sectional regressions show the effect of buy- and sell-latent liquidity, coupon, initial rating, and the two CDS market liquidity variables, on the average non-default component in the bonds. The sample consists of 1977 bond-month observations obtained by matching prices and monthly latent liquidities from the State Street Corporation database with CDS prices obtained from GFI, over the period from August 1999 to July 2005. We only include months for which we have observations on a minimum of thirty bonds. The non-default component is computed using the swap curve and the treasury curve. Figures in brackets are Fama- Macbeth standard errors. These regression includes all bonds that are less than two years old, because those are the ones for which the buy-sell difference is most prominent. We include only those months in which we have a minimum of 30 bonds can be included. The total number of months over which the coefficients are averaged and the number of observations is reported.